Eero Haavisto

GUIDING THE UX DESIGN OF IOT CHATBOTS

UNIVERSITY OF JYVÄSKYLÄ
DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION SYSTEMS
2019

ABSTRACT

Haavisto, Eero
Guiding the UX design of IoT chatbots
Jyväskylä: University of Jyväskylä, 2019, 58 p.
Information Systems Science, Master's Thesis
Supervisor: Tuunanen Tuure

Keywords: virtual assistant, assistant system, chatbot, IoT, Internet of Things, user experience, UX, design science, design principles

This thesis studies what are the principles to guide the design of an IoT chatbot user experience (UX). With the empirical research, the thesis creates a Design Science artefact, which is designed to serve as a framework for guiding the user experience design of an IoT chatbot. In addition, it aims to find out how a chatbot acting as a unifying channel for controlling user's multiple IoT devices could enhance the value of user experience. The thesis reviews previous literature to define the key concepts related to the subject. Moreover, the study will look at the literature of chatbot implementations and research in general and study how to guide the design of an IoT chatbot user experience. The thesis proposes that a unifying IoT chatbot controlling multiple devices in natural language could make managing IoT devices more convenient and user-friendly for the user, and widen the crowd of users of new technology.

TIIVISTELMÄ

Haavisto, Eero
Guiding the UX design of IoT chatbots
Jyväskylä: Jyväskylän Yliopisto, 2019, 58 s.
Tietojärjestelmätiede, Pro Gradu -tutkielma
Ohjaaja: Tuunanen Tuure

Avainsanat: virtuaaliassistentti, assistenttijärjestelmä, chatbot, IoT, Internet of Things, käyttäjäkokemus, UX, suunnittelutiede, suunnitteluperiaate

Tämän Pro gradu -tutkielman tavoitteena on selvittää, mitkä periaatteet ohjaavat IoT-chatbot -käyttäjäkokemuksen suunnittelua ja kehitystä. Empiirisen tutkimuksen tuloksilla tutkielma luo suunnittelutieteen (Design Science) artefaktin, jonka tarkoituksena on toimia viitekehityksenä IoT-chatbotin käyttäjäkokemuksen suunnittelussa. Lisäksi tutkimuksen tavoitteena on selvittää, miten chatbot, joka toimii yhdistävänä portaalina käyttäjän useiden IoT-laitteiden ohjaamiseen, voisi parantaa käyttäjäkokemuksen arvoa. Tutkielmassa tarkastellaan aiempaa kirjallisuutta, jonka perusteella määritetään aiheeseen liittyvät keskeiset käsitteet. Lisäksi tutkimuksessa tarkastellaan aiempien chatbot -toteutusten ja tutkimusten yleistä kirjallisuutta sekä tutkitaan, miten ohjata IoT chatbot -käyttäjäkokemusta. Tutkimus ehdottaa, että IoT-laitteet yhdistävä chatbotilla, joka ohjaa useita laitteita luonnollisella kielellä, on mahdollisuus tehdä IoT-laitteiden hallinnan käyttäjäystävällisemmäksi ja laajentaa uuden teknologian käyttäjäyleisöä.

ACKNOWLEDGEMENTS

I would like to thank the Department of Computer Science and Information Systems and my employer for supporting me throughout my studies in the University of Jyväskylä. The flexibility of the department and the employer has given me a great opportunity to carry out my studies while gaining professional experience in the field of information technology to support the theoretical knowledge gained from the University.

In addition, I would like to thank my Master's thesis supervisor, Tuure Tuunanen, for supporting this thesis by providing guidance in achieving the research objective. Also, I am truly grateful for the support I have received from my family and friends during my studies in the University and especially during the process of writing this thesis. As the former owner of the NBA team New Orleans Hornets, George Shinn, once stated: "There is no such thing as a self-made man. You will reach your goals only with the help of others." Thank you all for your much appreciated support along the way.

FIGURES

TABLES

ABBREVATIONS

AGI	Artificial General Intelligence
AI	Artificial Intelligence
ANI	Artificial Narrow Language
API	Application Programming Interface
CEO	Chief Executive Officer
CMS	Content Management System
COO	Chief Operating Officer
CRM	Customer Relationship Management
CSO	Chief Science Officer
CTO	Chief Technology Officer
DSRM	Design Science Research Methodology
IA	Intelligent Agent
IOT	Internet Of Things
MB	Megabyte
NLP	Natural Language Processing
PAAS	Platform as a Service
RAM	Random Access Memory
UI	User Interface
UX	User Experience

TABLE OF CONTENTS

1 INTRODUCTION

The connected data among humans and machines is changing today's industries, businesses, and consumer behavior. In my Bachelor's thesis, I mentioned as follows: "According to the studies of Gartner's Research Organization, it is estimated that in the year 2020 over 85% of our daily events are handled without human assistance. For example, the American vendors will be reduced from 18 million to only approximately 4 million. In addition, the amount of virtual sales assistants has grown 50% per year during the 2010s." Moreover, according to Gartner's research, by the year 2020 over 25 billion Internet of Things (IoT) endpoints will be in the consumer market alone. Kar and Haldar (2016) argue as follows: "IoT is a phenomenon, which is certain to play a major role in our daily interaction with the digitally connected world." Thus, it is important to study how to exploit the combined use of these two emerging technologies.

1.1 Motivation for research

IoT devices and their dedicated applications are rapidly increasing in the consumer market (Lee and Lee, 2015). IoT devices, such as smart lights, are easy to control through a user's mobile application with just a glance and tap. That said, the way the user operates the devices is somewhat different from other consumer smart devices (Bergman, Olsson, Johansson, Rassmus-Gröhn, 2018). The technology allows the user to also manage the devices remotely. However, what will follow when the amount of the user's IoT devices increases and all the different manufacturer's devices have their own dedicated applications and user interfaces? The user will most likely end up controlling multiple devices through multiple applications with the need of learning multiple user interfaces. Kar et al. (2016) state the problem as follows: "-- IoT systems also face a challenge of unifying User Interfaces (UI). It becomes increasingly difficult on users to keep track and access multiple applications, dashboards for every new

'IoT object' in their ecosystem. Hence unifying experiences across multiple connected things and providing them with a high degree of smartness for improved user experience is a key challenge." Thus, I propose a question: Could a virtual assistant, or a so called chatbot agent, act as a unifying management channel for the user to control and receive the statuses of multiple private IoT devices? And what would be the principles to guide the design of an IoT chatbot user experience (UX)? Moreover, IoT and chatbot technologies can be integrated with each other with little effort, since they share similar application programming interfaces (API), RESTful Web APIs. This means for example implementing new IoT devices into the user's management channel could be executed rather easily.

The lack of generalized guiding principles is a major motivator for this study. Prior research has focused on chatbots used for medical, educational, or e-commerce purposes, and implementations of such applications have already been in use for quite some time. However, the reviewed literature does not consider a detailed framework of chatbot UX design principles in order to serve as a unifying channel for the users' IoT devices. According to prior literature, it seems that there are various models of characteristic requirements for a chatbot. They all seem to have, however, different angles of approaching the subject, and to my knowledge little research have been done on UX design principles of a chatbot, especially in IoT environment.

Research done on the principles of chatbot design is still in its early stages, even though chatbot implementations have been around and in use for years already in various contexts. Since the implementations have spread in multiple fields of studies, a consensus of a generalized chatbot design principles is still lacking. It seems that various different chatbot implementations have been developed for multiple different tasks but little research is done on the opportunity to use chatbot as a unifying channel for a user to manage multiple IoT devices remotely. To be specific, to my knowledge it is still unknown what kind of principles or a framework should be taken into account when designing user experience for an IoT chatbot.

1.2 Research objective and research question

The objective of this research is to study how to guide the design of an IoT chatbot user experience. The goal is to design an artifact, which will act as a framework of UX meta design principles (Peffers, Tuunanen, Rothenberger & Chatterjee, 2007) for an IoT chatbot. I argue that it is crucial to fully exploit this growing technology and to provide beneficial value for developer organizations, and their customers (end-users). I propose that a unifying IoT chatbot controlling multiple devices in natural language could make managing IoT devices more convenient and user-friendly to the user. By pointing out the core principles and characteristics of such application, the knowledge of developing an IoT chatbot user interface and user experience can be extended. The

principles and characteristics will be focused on the requirements of how the UX should function in order to create a tool that benefits both the service provider and the end-user. To reach this goal I will examine the prior literature and implementations of chatbots, conduct an empirical study, and based the gathered results create the meta design principles applicable to the context of chatbots implemented in IoT environment. The design principles will be focused on the developers' requirements of how the software should function in order to create a tool that benefits both the service provider and the end-user. The goal of the thesis is to answer the following research question:

- What are the principles to guide the design of an IoT chatbot UX?

1.3 Thesis structure

The thesis is structured as follows. First, I will introduce the reader to the subject and present the motivation for the study along with the research question. Then I will define the key concepts and review the previous literature related to the research subject. After the literature review I will present the research methods and conduct an empirical study by interviewing Finnish chatbot developer organizations. Finally, I will cover the findings and discussion together with the conclusion. In addition, I will present the limitations and contributions of the research.

2 USER EXPERIENCE

> Good UX is the consequence of fulfilling the human needs for autonomy, competency, stimulation, relatedness, and popularity through interacting with the product or service. (Hassenzahl, 2008)

The International Organization for Standardization (ISO) (FDIS, 2009) defines user experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service". In other words, UX is the value gained from the user's interaction with a product or service. Hassenzahl (2008) argues that there are two sides to the definition of UX; what it is and how it is created. Hassenzahl and Tractinsky (2006) summarize the key essence of UX by stating that the aim of UX is to "focus on how to create outstanding quality experiences rather than merely preventing usability problems." To be specific, the researchers want to shift the focus away from minor product flaws in order to bring forth a superior and engaging user experience.

Hassenzahl et al. (2006) argue that one should not 'design an experience' but to 'design *for* an experience' by providing the design experiential elements. In today's daily life, UX is no longer a mere concept of functionalities but an ensemble of interactive systems and environments (Hassenzahl et al., 2006). The evolution of UX is driven by three factors: commercial vendors, designers, and scientific community (Hassenzahl et al., 2006), which alongside shift the development of the domain depending on the technology markets. The goal of UX is simply to create a satisfactory interaction with a product and exploit the experience to gain user loyalty towards the product (Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos and Sinnelä, 2011). In addition, UX aims to design for pleasure in order to increase the quality of a user's personal life.

2.1 Contents of User Experience

Hassenzahl et al. (2006) argue that the term 'user experience' consists of various meanings, such as "beauty, hedonic, affective, and experimental aspects of

technology use." Hassenzahl et al. (2006) divide UX into three affecting top-level perspectives: (1) *Beyond the Instrumental*, (2) *Emotion and Affect*, and (3) *The Experiential* perspective (Figure 1). The perspectives consist of different facets, which describe user's interactions with the used technology, and affect the individual user experience on varying levels depending on the context or environment. The *Beyond the Instrumental* facet consists of hedonic, holistic and aesthetic aspects, such as human needs, beauty and pleasure that are perceived by an individual user. The *Emotion and Affect* facet deals with aspects, such as human decision-making and consequences. Whereas, *The Experiential* facet consists of various user state elements and their combinations and interrelations, which modify each other over time and produce the actual user experience. However, UX as a concept is highly subjective and context-dependent that emphasizes the user's hedonic values (Hassenzahl et al., 2006). Thus, Hassenzahl et al. (2006) point out that it is difficult to fully define UX, and they admit their model does not fully cover UX as a whole either. On the other hand, since the concept varies significantly, one can consider UX to provide a large

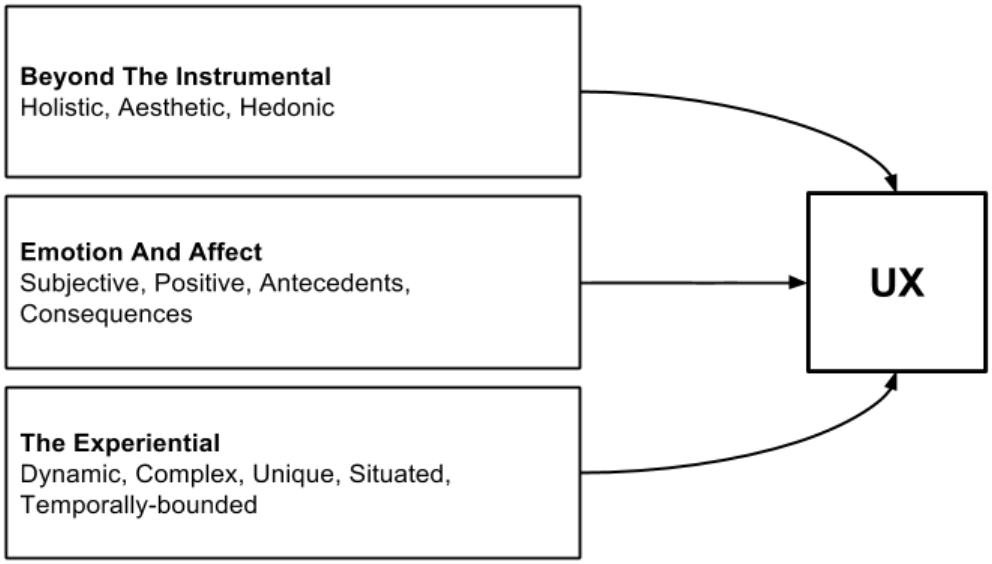

Figure 1: Facets of UX (Hassenzahl and Tractinsky, 2006)

amount of room for its further development.

2.2 Measuring User Experience

How do we measure and design UX then? Firstly, UX has to some extent originated from usability and therefore their measurement models are alike (Tullis, Albert, Dumas, and Loring, 2008). Secondly, Law and Van Schaik (2010) argue that UX is a refined shape of *satisfaction* metric, which is one of the

metrics used to measure usability. Previous studies (Nielsen, 1996; Seffah, Donyaee, Kline, and Padda, 2006; Tullis et al., 2008; Everett, Byrne and Greene, 2006) propose a number of varying tables of usability metrics depending on the context used in. It is reasonable to argue that the five most common usability metrics used among academic models are *effectiveness, efficiency, satisfaction, safety* and *accessibility*. These metrics can be applied to measure UX as well as usability. The major difference between UX and usability is that UX development is a non-task-oriented concept aiming to improve the hedonic values, while usability is a task-oriented concept dealing with the pragmatic values (Law et al., 2010).

UX can be assessed between two types of behavioral models: measurement model and structural model (Law et al., 2010). The user experience measurement model (Figure 2) measures a specific domain, which consists of four correlating main constructs (or latent variables) that are measured with manifest variables (Law et al., 2010). The data for the model is collected via user questionnaires. The four constructs include: (1) *Pragmatic quality*, (2) user's perceived *Hedonic quality*, (3) *Beauty*, and (4) *Goodness*. *Pragmatic quality* refers to the perceived usability of a product and how well it supports the user's 'do-goals', such as switching the lights off in a room or sending a text message on a mobile phone (Hassenzahl, 2008). *Hedonic quality* deals with the motivation, human need and pleasure of using a product, and its 'be-goals', such as being unique or being adequate and standing out from the crowd as a superior (Hassenzahl, 2008). In fact, according to Hassenzahl (2008), hedonic qualities are the actual drivers of user experience, and thus should be emphasized in UX research and development. The *Beauty* construct refers to how the aesthetics of a product pleases the user. For example, one may find the exterior design of a TV pleasing to the eye and put an emphasis on its effect on user experience. The last construct, *Goodness*, sums up the user's perceived levels of all four constructs and the overall quality of a given product (Law et al., 2010). It is crucial to keep in mind that user experience is always measured individually, and thus the *Goodness* of a product is dependent on how an individual assesses the other three constructs.

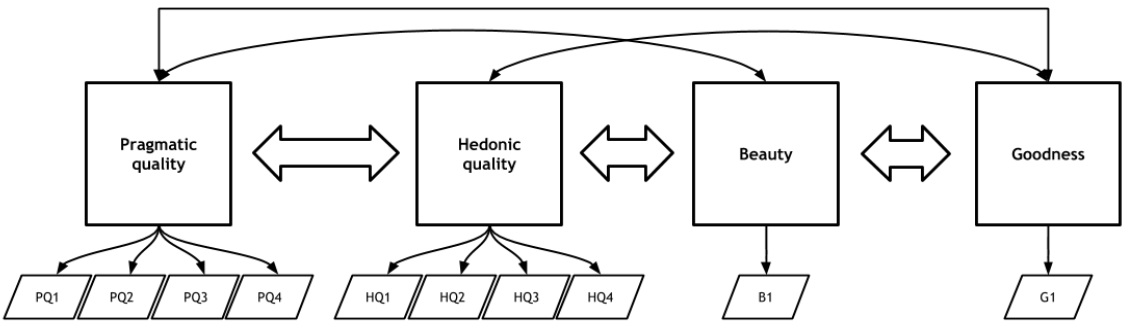

Figure 2: UX measurement model (Law and Van Schaik, 2010)

The structural cause-and-effect model (Figure 3) addresses relations between the constructs of the user experience measurement model (Law et al., 2010). In Figure 3 Law et al. (2010) indicate that in this example *Usability* acts as the only variable and it has a positive effect on *Pragmatic quality*, whereas *Pragmatic quality* has a positive effect on *Goodness*. It is noteworthy that *Usability* has no effect on *Hedonic quality*, which has a positive effect on *Goodness* and *Beauty* only. The study of Kujala et al. (2011) indicates that measuring UX should be conducted over a long period of time rather than 'first-time' experiences, since hedonic aspects change radically over time.

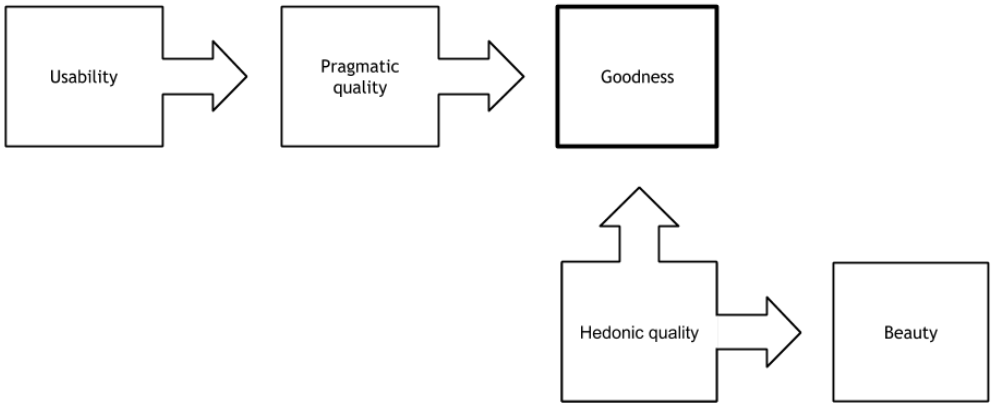

Figure 3: UX structural model (Law and Van Schaik, 2010)

The growing demand of interactive and multifunction products has increased the interest of UX research in the scientific community (Hassenzahl et al., 2006). According to previous studies, hedonic values and attractiveness have increased their importance in UX design and in the significance of user recommendations (Hassenzahl, 2008; Kujala et al., 2011). In the 1990s and early 2000s usability was enjoying its 'glory' times, since usability of a product was the top priority in product development and UX design had not been developed as far (Nielsen, 2008). The focus of UX has slowly but surely been shifted from usability-centered view to a more enjoyment-centered view. Thus, it is safe to argue that user experience is currently going through its 'loyalty decade', where the user experience determines the success of a product (e.g. Apple fanatics) (Nielsen, 2008).

3 IOT CHATBOT

According to prior research, the amount of IoT devices is inevitably increasing in our daily lives and spreading to the consumer market, and to various user profiles (Lee et al., 2015). As mentioned above, there are multiple different IoT devices in the consumer market that have various different user interfaces, for example in mobile applications. Some of the user interfaces are well designed, and some of them more or less confusing for the user to use and interpret (Bieliauskas and Schreiber, 2017). Smith and Mosier (1986) define user interface (UI) as a the collective "aspects of system design that affect system usage". In other words, user interface is the environment where the interaction between human and computer takes place (Banerjee, Nguyen, Garousi, and Memon, 2013). In this thesis, graphical-user interface (GUI) will play the main role when regarding to UIs. As the name suggests, graphical-user interface interacts with the user in a graphical environment through user inputs, such as mouse-clicks, selections, and text inputs (Banerjee et al., 2013). Kar et al. (2016) argue that chat environments (i.e. Facebook, Slack, Telegram) are vastly distributed and adopted among consumers. Thus, they propose that since chat applications are familiar to the common consumers and function by using natural language, a chatbot could act as a low threshold for introducing and managing new IoT technology in a more user-friendly approach.

According to Bieliauskas et al. (2017), for the user to be able to interpret and explore technological architecture, it is important to "generate dynamic visualizations based on the source code of the application." However, often dynamic visualizations may appear too complex for the common user. Bieliauskas et al. (2017) propose a solution for this problem by developing a Conversational User Interface, which understands the user's natural language inputs and is able to understand and track the context provided. The authors describe it as "an approach that provides a more natural way to interact with computer systems compared to a classic graphical user interface." They argue that it provides more human-to-human like interaction. The Conversational User Interface is able to provide an output for the user, for example a solution to a problem or an answer to a trivial question. The core idea is to provide a conversational environment with little or no visualization, such as confusing graphs and data reports.

Bieliauskas et al. (2017) divide conversational based interfaces into two categories: assistant systems and chatbots. They define assistant systems as "software agents that are more general than a chatbot" and they emphasize that the goal of virtual assistant systems is to direct the user to a suitable subsystem rather than providing the solution to the user directly by themselves. Bieliauskas et al. (2017) point out that the increase of assistant systems' popularity happened through the emerge of virtual private assistants. Examples of such assistants are Amazon's Alexa, Microsoft's Cortana, and Apple's Siri. These assistants are able to provide a solution to a question or a problem, and they are mainly controlled through user's voice commands. However, unlike a chatbot, they lack the capability of completing more specific tasks and the capability of keeping track of the context (Bieliauskas et al. 2017). In Figure 4, Khanna, Das, Pandey, Hussain and Jain (2016) present a "conceptual diagram for a natural language smart system", which is a simplified concept of a speech based smart system.

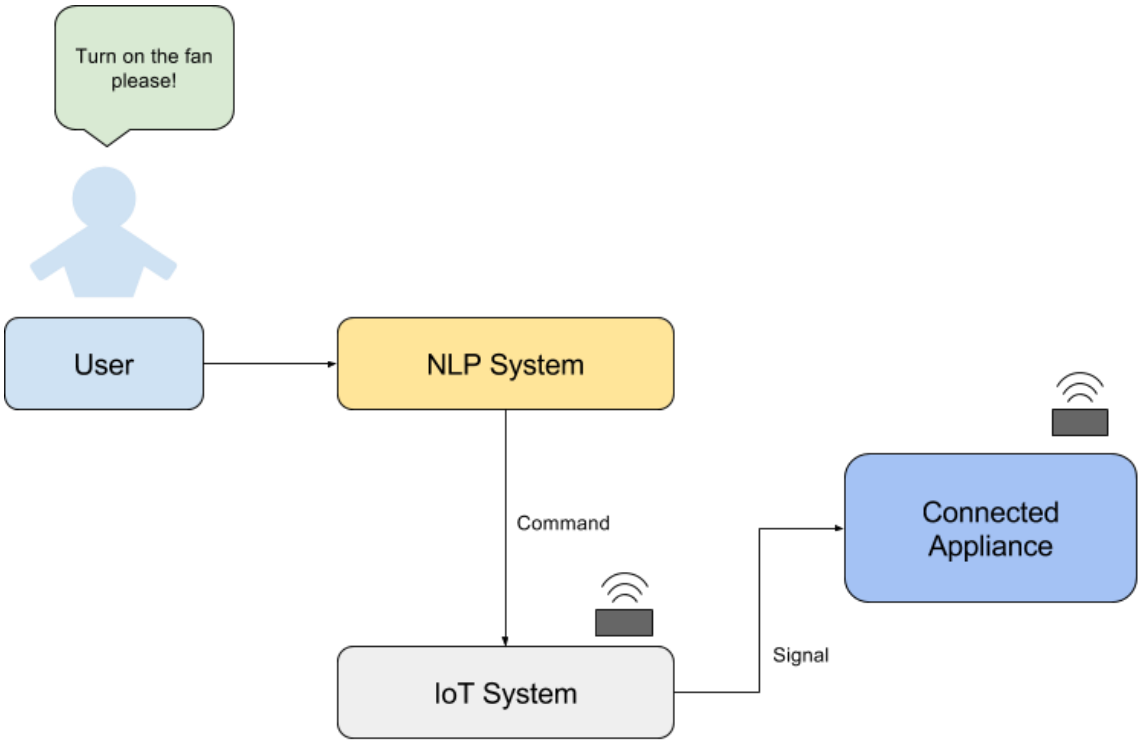

Figure 4: Conceptual diagram for a natural language based smart system (Khanna et al., 2016)

As mentioned, chatbots are interactive systems that communicate with a human user and can be given tasks (inputs) using natural language. In addition, they can be integrated with third-party softwares through application programming interfaces (APIs) to allow the user to interact with them inside the platforms (Bieliauskas et al., 2017). The key feature that separates chatbots from assistant systems is that chatbots are able to track a conversation and follow the context

as we can see in Figure 5. In the presented figure, the chatbot tracks the context and is able to use information from previous user inputs without the need of asking the location again from the user. This feature makes the user experience more natural and approachable.

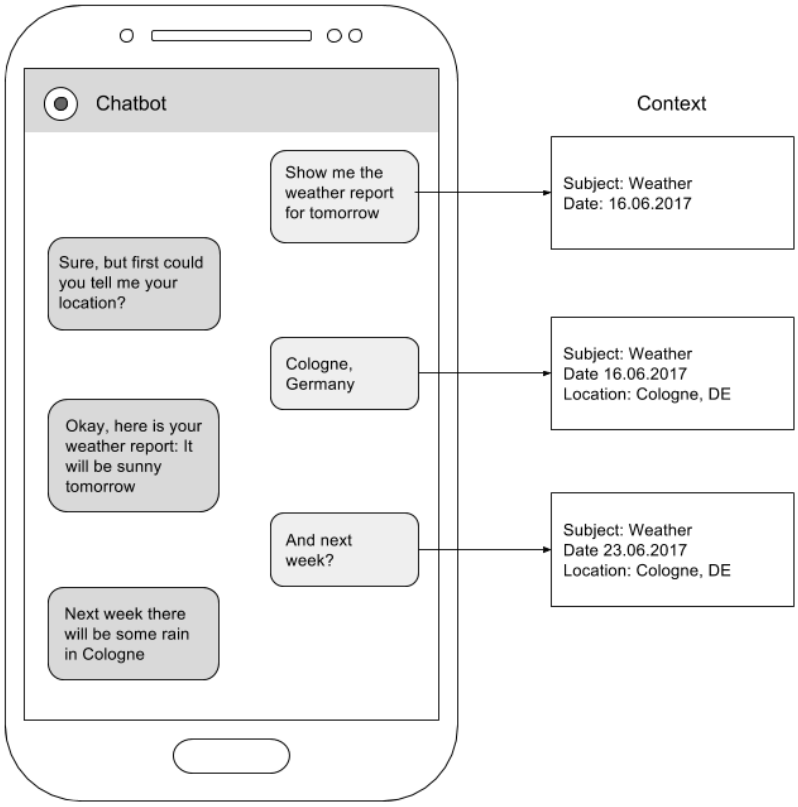

Figure 5: A chatbot agent's extraction process of context information (Bieliauskas et al., 2017)

However, I argue that in designing a smart chatbot, that has the access to the user's private data, certain level of caution must be taken into account. Mori (1970) provides a theory called Uncanny Valley, which measures a robot's affect for the viewer. The more the robot resembles a human, the more familiar the user experiences it. However, as the resemblance of a human increases, the viewer meets a point where the robot starts to appear disturbing in an unpleasant way. Mori (1970) argues that the positive effects of a familiar resemblance decrease when the viewer meets the point of creepiness. The point or "dip" where this occurs is when the robot is relatively human-like, but not fully. This is called the Uncanny Valley. I believe Mori's (1970) theory is applicable in this research and its context, since in developing a smart chatbot that is capable of managing a user's personal IoT devices, one must be very careful in designing its design principles and avoid creating something alienating.

To make the interaction with a human user and a computer system fluent, it is crucial to take into account the behavior and characteristics of the system when designing it. Kar et al. (2016) refer to Schermer (2007) by stating that the key properties of chatbots, or software agents, include seven characteristics: "(1) reactive, (2) pro-active and goal-oriented, (3) deliberative (4) continual (5) adaptive (6) communicative, and (7) mobile". When it comes to the behavior of an IoT chatbot, Schermer's (2007) model of agent characteristics could be a suitable basis for developing a framework of design principles for a chatbot in IoT environment, and how the user would interact with the system. Schermer (2007) studied software agents as surveillance tools and the effects of how individual liberty and privacy might be at risk in situations where agent-based surveillance is used. Schermer emphasizes that an agent does not need to fulfil all characteristics to be considered as an agent.

In addition to the characteristics by Kar et al. (2016), Chaturvedi, Dolk, and Drnevich (2011) examine the characteristics of virtual worlds (i.e. SecondLife, virtual reality, simulators) and propose a set of design principles for virtual environments. Moreover, they propose a set of software agents' core properties in agent-based virtual worlds (Table 1). The research of Chaturvedi et al. (2011) focuses on agent-based simulation technology. From their theoretical review, Chaturvedi et al. (2011) created a large-scaled agent-based virtual world (ABVW) and tested it in practice. The combination of Schermer's (2007) model of software characteristics, the model of algorithms by Baral and Gelfond (2000), and the set of software agents' core properties in agent-based virtual worlds by Chaturvedi et al. (2011) could be used as a basis of what type of characteristics the chatbot system should rely on.

Property	Description
Autonomy	Absence of a central, or top-down, controller
Local interactivity	Agents react to, and/or interact with, neighboring agents and with other aspects of the environment
Spatial presence	Agents typically are positioned in, and act in, some form of an n-dimensional space
Rules of engagement	Agents "behave" according to specified rules or heuristics that may change over time
Perception	Agents can sense their neighborhood (e.g., the presence of other agents residing therein)
Memory	Agents may be able to record some of their perceptions
Communication	Agents may be able to communicate with other agents
Motion	Agents may be allowed to move around in their landscape

Table 1: Software agents' core properties in agent-based virtual worlds (Chaturvedi et al., 2011)

Baral et al. (2000) studied and proposed a model of algorithms for "the design of software components of intelligent agents capable of reasoning, planning and acting in a changing environment." In addition, they state that it is important to know how to design intelligent agents (IA) such as "development of various types of control systems". Baral et al. (2000) argue that designing intelligent agents differs greatly from traditional software system design, since an agent should (1) be aware of its capabilities and goals, and the domain where it is going to act, (2) actively and autonomously expand its knowledge of its environment and the entities it is in contact with, (3) be capable to reason, (4) and have the capabilities of exploiting its expanded knowledge and reasoning to plan and execute tasks.

3.1 Chatbot

Chatbot is a programmed, interactive system, which is able to talk with a human being in natural language through textual or auditory channels. The amount of chatbots in the digital world has increased rapidly and they can be encountered with on various websites and mobile applications. (Van Lun)

To date, chatbots are able to communicate with the most common natural languages. However, the natural language processing (NLP) and visual design of different chatbot implementations vary significantly (Van Lun). In most cases the conversation with a chatbot is triggered by a human user. The chatbot reacts to the user's input and provides the user an answer or a question related to the context (Huang, Zhou, & Yang, 2007). Most chatbots exploit dialog management modules, which control the conversation and the chatbot knowledge database to provide a proper output for the user (Huang et al., 2007; Kar et al., 2016) (Figure 6). The chatbots are often preprogrammed with multiple answer templates and the system attempts to utilize the templates in its output to provide a proper answer in natural language (Huang et al., 2007). Thus, the goal of this thesis is to theoretically exploit chatbot technology as a simple channel for the user to manage multiple IoT devices.

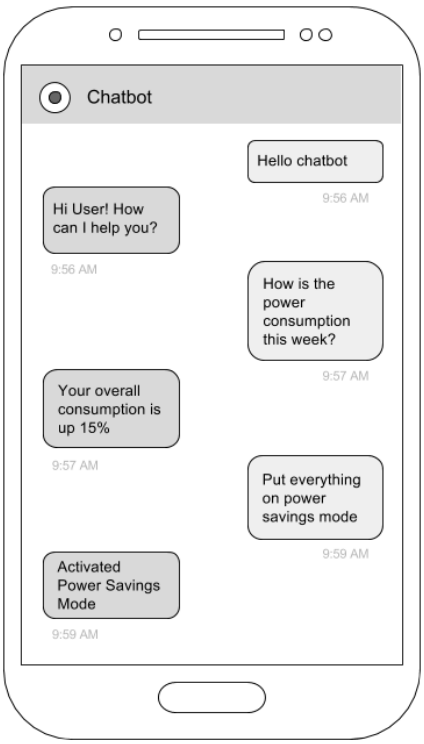

Figure 6: Sample of an IoT Chatbot-User conversation (Kar et al., 2016)

Figure 7: The DSRM Process Model (Peffers et al., 2017)Figure 8: Sample of an IoT Chatbot-User conversation (Kar et al., 2016)

3.2 Internet of Things

The Internet of Things (IoT) consists of a managed framework of numerous devices around the world that are interconnected and in rich, personalized interaction (Kummerfeld and Kay, 2017). Such devices include for example smart home devices (i.e. kitchen appliances, lighting, locks, electric vehicles) that a user can control remotely, for example through a smartphone application. Kar et al. (2016) argue that IoT has the capabilities to significantly shape the digital age and create "a varied range of technologies". By collecting various data over multiple interconnected things and objects, a great amount of resources come at hand, which need to be transformed into a more controlled and comprehensible form (Kar et al., 2016). In this thesis, I plan to integrate the consumer IoT environment including multiple personal IoT devices with a chatbot, which can access the data of a user's IoT devices and create a unifying channel for the user to manage their IoT devices in natural language. Since the environment will be based on cloud services, managing devices can be done remotely.

3.3 Artificial Intelligence

> I believe that in about fifty years it will be possible to program computers... to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning. (Turing, 1950).

In order to determine the term Artificial Intelligence, one must first present the question of "What is the definition of intelligence and what does it actually consist of?" It is challenging to describe intelligence in all of its meanings, and there is not one definition for it but several. A definition put together by 52 leading researchers of intelligence describes intelligence as:

> A very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on," "making sense" of things, or "figuring out" what to do. (Gottfredson, 1997)

Artificial Intelligence (AI) on the other hand can be described in a similar way as above with one exception; it is man-made. During the last few years, the development of Artificial Intelligence (AI) has sped up rapidly and it has rather imperceptibly been implemented into our everyday lives. However, Artificial Intelligence has existed longer than one would assume, since Artificial Narrow

Intelligence (ANI), also known as Weak AI (Chalfen, 2015), has existed for several years already (Sharma, 2016).

In general, Artificial Intelligence can be divided into Weak AI, Strong AI and Super AI (Siau and Yang, 2017). Weak AI is considered as intelligence that is able to execute simple tasks only in specific areas, such as mobile applications and smart cars (Siau et al., 2017; Sharma, 2016). Strong AI, also known as Artificial General Intelligence (AGI), is able to operate in more than one specific area and is considered as intelligent as a human being (Siau et al., 2017; Sharma, 2016). Super AI is still at a level of a hypothetical concept but is considered to be significantly more intelligent than a human being in every level of intelligence (Sharma, 2016).

Hovy, Navigli and Ponzetto (2013) describe how previous studies emphasize the importance of knowledge as the core of Artificial Intelligence (AI) and Natural Language Processing (NLP). For years, one of the major challenges with knowledge and technology has been the so called 'knowledge acquisition bottleneck', which can be defined as the difficulty of implementing human-level tasks and intelligence into technology (Hovy et al., 2013). However, the current rise of online developer communities have shown a significant effort in exploiting large collaborative resources to further develop "knowledge-rich approaches in AI and NLP" (Hovy et al., 2013). The collaborative communities around the world exploit large amounts of "wide-coverage semantic knowledge" and are able to extract it with statistical methods to accelerate the development of machine deep learning and deep knowledge (Hovy et al., 2013).

As early as in the 1950s, the Turing test developer, Alan Turing (1950), predicted that computers would eventually pass the *Turing test*. To be specific, Turing predicted that by the year 2000 computers with a Random Access Memory (RAM) exceeding 119 megabytes (MB) would be able to trick 30% of human beings into believing they are not a machine during a five-minute test. In addition, Turing predicted that machine learning would be an important part of building efficient machinery. To this day, this argument is still considered credible among modern day Artificial Intelligence academics. (Haavisto, 2015)

4 RESEARCH METHODOLGY

This research will apply the general methodology of Design Science framework for Information Systems research (Peffers et al., 2007) to create an artifact of IoT chatbot design principles framework. The goal of this thesis is to design an artifact, which is a framework of meta design principles (Peffers et al., 2007) for an IoT chatbot. To reach this goal I will examine the prior literature and implementations of chatbots, conduct an empirical study, and based on the research create the meta design principles applicable to the context of chatbots implemented in IoT environment. I believe it is crucial to fully exploit this growing technology and to provide beneficial value for developers, and their customers. The design principles will be focused on the developers' requirements of how the software should function in order to create a tool that benefits both the service provider and the end-user.

Semi-structured interviews of chatbot and IoT developer organizations will be executed as a field study to gather research data. The goal is to gather several developers' opinions into one and use it in future research and development. I will not participate any end-users in the research. The interviews will be about 45 minutes long and I will try to gather 10 developers to conduct the interviews with. I will create the questionnaires in an open-ended way in order to provide flexibility for the respondents, and to gather well-rounded respondent point-of-views. Interviewing the developers directly in one-to-one sessions I will be able to gather the needed comments and opinions of the interviewees, and open up the conversation. I will try to conduct the interviews at the developer's work places. The interviews will be recorded. The interviewees will be representing an organization and confidential business information may be needed to take into notice.

4.1 Methods and theories

In order to provide a guiding framework for designing an UX for an IoT chatbot, meta design principles need to be developed. Design principles are an element of Design Science Research Methodology (DSRM) (Figure 7) (Peffers et al., 2007). Peffers et al. (2017) define design science as a methodology that "creates and evaluates IT artifacts intended to solve identified organizational problems".

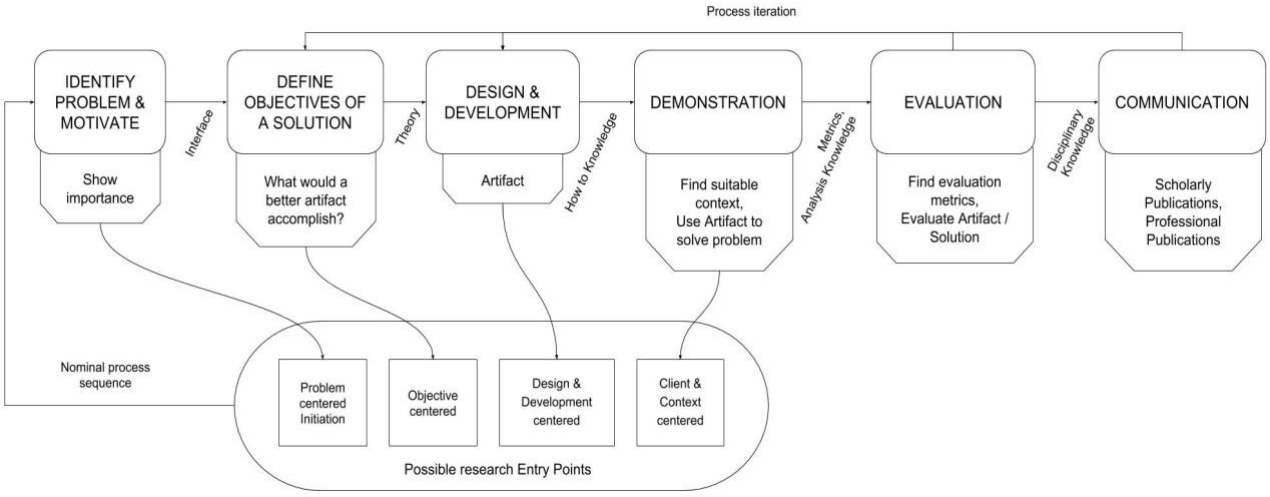

Figure 9: The DSRM Process Model (Peffers et al., 2017)

Figure 10: The DSRM Process Model (Peffers et al., 2017)

These design principles could guide future design of IoT chatbot user experience.

This research starts by focusing on the first step of the DSRM: *Identify problem and motivate*, which creates the foundation for the importance of the study. The motivation for this research is mentioned in Chapter 1. In the next step, *Define objectives of a solution*, the research brings forward an innovative idea of a portal operated through a chatbot to control consumers' IoT devices by using natural language, which has the possibility of simplifying the use of multiple IoT devices and possibly increase the amount of IoT devices usage among consumers. To be specific, this research focuses on how to guide the UX design of such a portal. The objective definition for this research is mentioned in Chapter 1. In moving on to the next step, *Design and development*, the research reviews previous literature and theories to contribute the empirical study for creating an IoT chatbot UX design artifact. This research does not include a practical demonstration to evaluate the validity and reliability of the study, but

an external evaluator (in this case the Master's thesis supervisor) reviews the solution.

4.2 Data collection

The research data was collected through semi-structured interviews. End-users did not participate in the interviews. Google.com and LinkedIn were used to search for Finnish chatbot and IoT developer companies' representatives. The representatives were contacted by emails or LinkedIn messages.

The interview was put together in a manner that would best suit the future development of user experience among chatbot systems. The questionnaires were created in an open-ended way in order to provide flexibility for the respondents, and to gather well-rounded respondent point-of-views. Interviewing the developers directly in one-to-one sessions I was be able to gather the needed comments and opinions of the interviewees, and open up the conversation. The interviewees participated in the research were gathered from Finnish IT companies specialized in the development of either chatbot or IoT technology. The participants job titles and responsibilities varied from Chief Technology Officer (CTO), Chief Operating Officer (COO), Chief Science Officer (CSO) and Chief Executive Officer (CEO). A total of six participants were interviewed via Skype video conference call tool. The interviewees were informed that the interview was completely confidential and anonymous. In addition, the interviewees were told that they did not need to answer a question if they did not want to (e.g. business critical information). The interviews were recorded and lasted from 30 minutes to an hour each.

The goal of the study was to gather interview data from Finnish IT organizations' representatives in order to provide shared knowledge of the development of user experience among chatbot systems, especially for the Finnish market. In addition, the results can be used in future research and development. The design principles were focused on the developers' requirements of how the software should function in order to create a tool that benefits both the service provider and the end-user. The research results may be used for further development of chatbots in an IoT environment and possibly in other applicable areas, such as ecommerce.

4.2.1 Interview structure

The interview consisted two main themes: chatbot and user experience. However, the main focus was on the latter theme, and for that reason more questions were directed to the domain of user experience. The interview was constructed of a total of seven key questions that were asked from every interviewee. In addition, in some interviews sub-questions related to the subject

were asked when considered necessary or an answer needed to be more elaborated.

Each interview started with a presentation of the interviewee. They would state their job title, job history and experience with chatbot and IoT technology. In the next part the interviewees were presented a use case (see Appendix 1: "Kuvittele") that would lead their current mindset more effectively into the research area and also make sure the interviewees were on the same page with the interviewer about the research subject. The use case was presented to the interviewees in Finnish. A translation in English is presented below.

> You are sitting in a lecture hall listening to an interesting seminar that you cannot leave. After the seminar you are leaving for your summer cottage for the weekend in your brand new Tesla. You happen to come up with thoughts about trip-related questions that need to be resolved quickly so you can prepare for the necessary actions as early and efficiently as possible. On your mobile phone you have native applications for each of these devices and their needs. Thus, you would need to go through all the applications one by one, which all have their own user interfaces that are unlikely to share the same user experience, and therefore do not work logically together. What if you could instantly ask all the required questions and perform the necessary actions with your mobile device by using only one chat portal in natural language? You would not bother other people and you would not have to leave the seminar. The actions needed to take care of would be sorted out and managed in no time, and you would be all set for the weekend.

4.3 Data analysis

A thematic analysis was carried out to identify the essentials, or common themes, of which the collected data is composed. By identifying and categorizing the observed themes perform a more detailed analysis was created. The design principles were chosen by analyzing the results of the interviews. The aim was to understand and promote the theoretical basis of design, the basics of new tools and techniques, and to create a platform for future systems.

5 FINDINGS

5.1 Interview questions

This section is divided into seven themes based on the interview questions in the order they were presented to the interviewees. Each theme, or chapter, includes a summary of the findings regarding the question.

5.1.1 'One application to rule them all' - First thoughts

> It is a bit like a computer's command line basically. It is useful if you know what you are looking for. - Interviewee

After reading the example use case the interviewees were required to answer a question: "What type of thoughts does this use case raise with you?"

A user has a need to handle a wide range of actions within an entity and in this example use case the entity is the user's cottage and all the IoT devices it contains. For half of the interviewees the given example case sounded like a familiar, logical and sensible idea. Especially when considering the Finnish consumer habits and culture in general. All of the interviewees, however, found the example case interesting and it raised various, although, quite similar thoughts among the group. The common theme was the idea that the user does not need to interact with other people, but IoT devices can be controlled and monitored through one master portal by using one's mobile device. Interviewees mentioned that the example case resembled a noted trend in user behavior and a common focus of development in user experience. Some organizations have already started conversations on how to implement such a portal system. As an example, one organization executed a test project where they integrated their software with voice-to-text and text-to-voice technology and linked it with an electric car to control it through voice and text commands.

Although the example case was considered fascinating, a half of the interviewees were relatively sceptic and challenged the native language

interface. Their main concern was that a mobile device and natural language are a reasonably bad combination, since writing on a mobile device is significantly slower. In fact, they considered voice command as a superior solution to communicate with an IoT system, since voice command can be considered as an intrinsic user interface to human beings rather than typing text on a mobile device. The interviewees found that any web interface can do the same thing in just as straightforward way, if not even better. The skeptic interviewees argued that attempting to replace all the user interface technology and user interface information that have been accumulated over the past decade with a bot user interface is an extremely poor idea. Swiftly throwing away all the information and knowledge that have been accumulated so far, and beginning to come up with something entirely new to the user interface concept was considered relatively doubtful. Moreover, one interviewee stated that there is no need for the use of natural language in the example case, and that the strength of a chatbot is in building a dialogue where it can provide more of a humane user experience.

A common feature that most of the interviewees mentioned and found important is the system's capability of personalization. A personalizable dashboard that gathers the desired trackable information was considered as a vital user interface element. In addition of being personalizable, the system should have a some level of automation and proactivity. For example, whenever the user informs the bot about an upcoming event the bot would provide the user all the regarding information at one glance. IoT devices that do not require active tracking but may require random actions from the user, should be capable of automatically notifying the user for situations that may need the user's attention. The user should be able to inquire the current statuses of each IoT device separately and provide the user a full report. In addition, a chatbot was considered useful in situations where the application does not provide as much information to the dashboard as desired by the user. In such situations would be convenient to have a way for the user to input an inquiry of additional information in text format and the bot would be able to produce that information, and automatically add it to the user's personalized dashboard. In addition, the bot should verify from the user whether they would like to see this information in the future. One could argue that the role of the bot would be a personal assistant, which runs in the application as a supplement and not necessarily act as the core of the system.

A valuable point was brought up that considered the argument that a chatbot itself as a user interface is not the one solving the processes or issues, and the system should be operating in a strictly defined environment. The context could be compared to a computer's command line. The command line can be considered useful if the user knows what they are looking for and what they are attempting to achieve. A mutual consensus among the interviewees regarding the capabilities of a chatbot was that a chatbot is a good user interface for performing only certain predefined tasks.

5.1.2 Chatbot solutions

The second question, following the initial thoughts and feelings of the interviewees, dealt with the chatbot system developed by the interviewee's organization and how it could be implemented and used in the example use case.

All of the interviewed organizations stated that their chatbot solution would suit the example case. Even though, the chatbot would have a certain role in the ecosystem, several organizations mentioned that currently it is not the one solving the problems. The interviewed organization's usage of chatbot technology varied from coaching services and Platform as a Service (PaaS) solutions to customer service agents. The chatbot system has acted as a solution to reducing the number of chat conversations in customer service centers. An analysis of the performance of a customer service center was executed by one of the participated organizations, which resulted in a total of 30% of all incoming chats included issues concerning relatively simple problems, such as lost user passwords. In these type of situations it is quite natural to have some kind of user interface that proactively asks the user what the current problem is.

All of the interviewed organizations have noted that users tend to ask their bots irrelevant questions in order to test the bot's capabilities. If the bot is not able to provide the desired answers to the their questions, the users may find the bot unintelligent or even worthless. This is more or less of a communication problem. The user is not informed well enough what the chatbot is intended for. The user should be informed right at the beginning of the interaction that they are talking to a chatbot and the bot can only provide answers to a specified area of questions. From the user's point of view, a chatbot is just a user interface for executing different actions. In many of the cases the end-user can ask the chatbot almost anything related to the subject, because the developers have also added casual responses into the chatbot's database.

5.1.3 Definition of UX

Next, the interview delved into a more personal question dealing with the interviewee's on perspective of the definition of user experience. The interviewees were encouraged to describe the domain based on their personal experience. The interviewees were asked to define the term user experience in their own words. The answers varied to some extent but one key element appeared to be mutual: natural feel of use. This section will present examples of the interviewee's answers as quotations.

> User experience is ultimately about how straightforward, easy and pleasant the process is. User experience can be measured mainly by how little frustration the user experience causes in the users. If the process does not bring about significant emotional reactions in the negative direction, then the user experience has been good.

> If a person wants to execute a task, they can do it without becoming frustrated or facing interfering issues during the user experience. Executing a task should feel natural. If the user is not able find how to execute the task, the user will become irritated and may consider it as a poor user experience.
>
> In many cases a user is in a need of a solution to a problem. The user starts to talk with a chatbot, asks a question, gets an answer and exits the conversation. Getting a solution to a problem is, in my opinion, a perfect user experience. A chatbot developed to entertain people, is a completely different concept, and in that context the user experience is quite different in what the users are trying to achieve. It is important to keep in mind that people have a purpose of why they visit a web site. They want to get something done. The user experience consists of how straightforward and easy it is to achieve the intent.
>
> Personally, I find that user experience can be just about anything. In my opinion, minimizing excessive tapping or writing and a lack of excessive verifications is a good user experience. Of course, some of the verifications are required to be there, but asking the user at constantly "Are you sure?" is not a very good user experience. A good user experience consists of high quality mobile support and the user must be provided with options to choose from, which speeds up the process.

5.1.4 Chatbot UX development process

The next part, fourth key question, was a question leading towards chatbot development and the user experience applied into it. The interviewees were asked: "In what ways has your organization started the process of UX development for a chatbot?"

Surprisingly, none of the interviewed organizations adhere to a systematical user experience design process. The organizations have mostly been focusing on how to technically accomplish the aimed solution for every delivery project. Only two interviewees mentioned that they have started to allocate more resources into UX design and UX data analysis. Also, only one interviewee mentioned receiving UX feedback directly from the end-user without any middlemen. The rest of the developer organizations only get feedback through their customers. In addition, most of the interviewed organizations are relatively young companies, and their initial focus has been in listening to the customers and their UX needs. The organizations mainly provide suggestions on the design based on their experience.

Most of the interviewed organizations have involved their customers in the development of their chatbot solution and its user experience design as much as possible. However, only two interviewees mentioned they have also included the end-users in the development of the UX design. The developer organizations have, together with their customers, handled the design ideas and experimented them with different models. The design of mobile user experience is strongly associated with the development. The design and development of the chatbot technology solutions continuously evolves and there will always be something to improve.

Almost every solution is based on some way of identifying the intent. One organization always strives to track and monitor how much value can be produced to the end-user, and how the user experience suits the context. It is important to consider in what type of language, for example, the answers and questions have been created. In case the database includes lots of questions that the bot should know the answer to, but which are relatively similar to one another, it is really difficult to say what the user's intent really is. Even if the artificial intelligence in the background worked really well, there still are difficult answers that are valid for many situations, but not really for anything.

One organization aims to blend in and mix the answers to cover as many questions as possible. For example, they take two different cases and blend them into one, and as a result multiple questions get the same answer. They aim to cover the risk of a gap between the two cases. The user experience is also influenced by how well the artificial intelligence works in the background.

High quality and versatile answers are two of the main keys in chatbot user experience development. Another key is realizing the fact that chatbots are a quite new technology to many consumers. Various users who are interacting with chatbots are first-timers, and a large amount of them have the curiosity to try out what the chatbot is capable of answering to. The users tend to ask stupid questions just for fun, and the bot should, however, seem smart to the users in those cases also. It is important to notice that this also affects the quality of the user experience.

One of the most prominent things in chatbot development are the times when the customers ask how the organization guides their customers in chatbot UX design in general. Whether they guide their customers to design the chatbot's behavior as humane as possible or whether they suggest to notify the end-user immediately that they are talking to a virtual assistant. One organization stated clearly that it is extremely important to inform the end-user about the virtual assistant as early as possible.

In practice, the customer has the final mandate of deciding how the chatbot is going to behave to the end-user, and what type of answers it will provide. Most of the developer organizations have implemented a small set of questions and answers into the chatbot with an addition of trivial answers in case the users want to test the chatbot somehow. However, they have noticed that surprisingly few people really want to ask irrelevant questions. In addition, one interviewee believes the amount of such trivial questions will decrease over time as people get more used to chatbots. Also, the user behavior probably varies slightly among different age groups.

One organization stated that they are focusing on combining the structured and unstructured interaction and analyzing how it can be implemented efficiently. They faced quite interesting limitations and opportunities during the development. Some tasks are easy to perform through a text-based conversation and some tasks have in fact appeared to be more natural to be presented in plain fill-in form. It depends on what kind of

information is being collected and whether there are some clearly defined options or not.

One organization conducted a survey where a chatbot directed the conversation and asked a user various questions. The users felt it was relatively natural to interact with the bot and it seemed more comfortable for the users to talk to the bot than a real person. The most important reasons for these results were that the user could respond to the questions on their own time and had the opportunity to think for an answer for a long time if needed to. The chatbot has been found to be especially useful in these kind of guidance tasks and introductory discussions. In general, the intention of the developer organizations is not to completely replace human beings, but to provide the bot as an additional assistant in completing routine tasks.

5.1.5 Chatbot UX design values

Based on their personal point of views, the interviewees were next required to answer to a question of: "What type of elements do your customers appreciate in user experience and do they correlate with your organization's views?"

In most of the cases the developers have a fairly consistent view with the customers, which is perhaps due to the fact that the initial aim has been to design and develop in a customer-oriented way. The customer lists out their values, which the developer organizations strive to abide by in the design and development processes. As a technology provider, the developer organization's role in the user experience has been more of a consultative one. Though, as chatbot technology providers the organizations have experience and knowledge from similar project deliveries so they may provide advice on general level and guide the customer to the most optimum solution. The user experience design experience of the developers consists of more of a data-based view.

The developer organizations have been focusing on producing market value and solving the right customer problems. However, in some cases the customers are concerned on issues what the developer organizations may not have taken into account. There may raise concerns on the customer side, for example, how will the chatbot affect the customer's brand or publicity. Even when the chatbot solved the end-user's problems and therefore produced business value to the service provider, if the chatbot occasionally fumbles and seems unintelligent, it may affect the brand value negatively through user experience. It is difficult for a development team to determine what level of value is given towards the brand, since there is always the risk of the chatbot acting in an uncontrollable way, which may cost for the brand value. It is difficult to compare market value, for example customer service savings, against how it affects the brand value.

The end user's intent is to get a solution to a problem, which is the ultimate task for the bot to excel. In the end, it is quite a binary thing to declare whether the user's intent is reached or not. However, from the service provider's point of view, the situation is a bit different because their goal is to

lower customer support costs or enhance the work of a customer agent. From that point of view, it is not necessarily the most essential issue whether the bot is able to serve every client sufficiently. In fact, one interviewee stated that the chatbot being able to serve only a specific part of end-users is sufficient enough for the service provider to be able to lower customer service costs. According to the interviewee, the bot does not need to be able to provide everyone a perfect user experience, since if the bot is able to provide 20% of the users a good user experience, and the rest is directed to a human agent, from the service provider's point of view the costs have thus reduced by 20%. It depends from whose point of view the solution is considered. The fact is, that it is almost impossible to serve every user perfectly. It is important to come up with a compromise on what the values gained from the chatbot are. In addition, it is important to focus on how the user is directed to a human agent. If it is handled in an unobtrusive manner where the bot informs the user that it is not able help them and the user is instantly directed to a human agent, the user experience will more likely remain positive.

Often the customers' expectations on the chatbot's capabilities, such as self-learning abilities, are quite high. Another frequently mentioned preference was a simple chatbot environment with no human agents integrated, but clickable buttons which guide the conversations. As an example, the user should be able to easily click a button to indicate an interest in a current status of an IoT device. Some customers want a chatbot that is able to formulate answers independently, which is challenging at the moment and it is difficult to trust the chatbot providing only valid answers. It is important for the chatbot to be able to recognize the context the user is talking about, for example business issues, even though the user was transacting with the consumer side of the website. The bot should be able to instantly direct the user to the business customer service. It is important from early on not to have a user stuck in a wrong customer service portal.

Most functions and user experience designs are not shown to the user, and that is something to aim for. In a way, it is about controlling the user experience with keywords. Both the end-users and service providers eventually want to have more and more features in the chatbot, especially when they get more familiar with the chatbot technology and what its capabilities are. Customers simply want to have someone answering the end-users' most common questions around the clock. In addition, they want the bot to be able to log the visited users, direct the user to the right customer service unit, and retrieve information from Customer Relationship Managements (CRMs) or Content Management Systems (CMSs), and even store information or execute processes. The more people become accustomed to technology, the more complex tasks they want it to be able to perform.

Social media portals are often a concern among customers, and how well the social media platforms support the chatbot system. For the chatbot technology provider it is a difficult task to make sure for example the

functionalities of graphic elements in multiple social media channels function in the same way on different operating systems (e.g. Android, iOS).

5.1.6 Chatbot UX development methods

In developing user experience for chatbot systems, the interviewees were next asked whether there are any specific development methods their organization uses in the development of user experience.

Chatbots and related system environments are a relatively new area of technology in Finland. The Americans have long been developing artificial intelligence technology in large organizations, such as Apple, Microsoft, and Amazon. By contrast, looking at Finland, the Finnish culture and the Finnish language, it is safe to say that the artificial intelligence development and related technology are in their infancy. To this date, there is not a very clear consensus of how people interact differently with a human being than with a bot. Based on common sense, one would assume the interactions are different, but to date there is not a significant research done on how the behavior of a person changes when they are aware of interacting with a bot.

Only one of the interviewed companies mentioned their organization exploits a framework called *Persuasive Technology* as a UX development method for chatbots. The rest of the interviewees did not have a set of scripted internal instructions for UX development in their organization. The most common reason to this is that they have had various different customers and project deliveries in which they tend to look for what the user experience in every case is and what the most relevant elements are. In addition, most of the interviewees stated that their organization consists of only engineers and business personnel who lack the knowledge of user experience design. Only one organization mentioned they use an in-house user interface designer in providing ideas for the UX development process. Most of the interviewed organizations lack an in-house user experience specialist but are planning on hiring one. The developer organization's customers often have their own user experience consultants. However, this has resulted in a relatively flexible development process. It is safe to say that currently the user experience development is customer-oriented and case-specific.

5.1.7 Chatbot UX development in the future

Finally, the interviewees were asked the question of "What in their opinion will the development of chatbot user experience be shifting towards in the future?" The answers included keywords, such as: artificial intelligence, chatbot, sentimental analysis, voice command, natural language understanding, and hybrid model.

It is a difficult task to predict how the mass behavior of consumers will change. Not until the consumers consist of digital native people only, there will be people who simply do not want to associate with chatbot, IoT or AI

technology. Reviewing the history of information technology, no single paradigm has ever remained as the only one. Different technologies have always complemented each other and this case is in no way an exception. Even though the development may set its course on one area of development, it will, however, most likely take a few steps back in the future. Since the understanding of the technology increases while developing it further, not everything can be predicted. Eventually, people will turn back wanting to associate more with real people. The role of the human customer service in the future will change in a way that only skilled people are needed in solving complex cases. Simple, frequently recurring tasks that are needed to be taken care of quickly should be able to be done through a chatbot. However, in certain, more problematic situations, the user should be allowed to easily turn to a human service agent.

Most of the interviewees argued that in the future a combination, or a hybrid, of a chatbot and voice command will become the most common solution for controlling IoT devices. In specific, the solution would be constructed of both structural information elements and structural user interface elements. Half of the interviewees mentioned they have personal or professional experience of devices that are controllable through voice commands. One interviewee believes that public services will become part of consumers' IoT systems. Most of the interviewees stated that they are more comfortable talking to the bot in private but not in public places.

The natural language processing (NLP) and the understanding of the spoken language will grow and its significance will increase in the future as it will be integrated in the technology. At the moment, only the large organizations, such as Google, Apple and Amazon, are providing a major effort on the development, but the development will most likely spread to a larger community of developers. Unfortunately, Finnish is a relatively small language in the global market and Finland is significantly behind the large organizations in the development of NLP. Most of NLP systems work in English and other major languages. Finland will not achieve the same level with the Finnish language for years. The large development resources are allocated into English word processing and currently any artificial intelligence system works better in English.

The development of chatbot user experience is going more and more towards the solution that not only does the user get trivial information from the chatbot but the user can execute the desired action completely in the chatbot environment. Two interviewees mentioned that the development will go in the direction that in really specific situations chatbots are going to be really useful. If the context of the conversation is strictly defined and the conversation remains within the defined borders, it will begin to get more difficult for users to determine whether they are discussing with a bot or a human being. In addition, as chatbots become more familiar to the consumers, it will get less likely for people to "fool around" with the chatbot.

5.2 Chatbot UX framework

The goal of this thesis was to create an artifact that would guide the UX design of an IoT chatbot. The created artifact is a UX framework listing the core components of a successful chatbot UX. The research question this thesis aimed to answer was as follows:

- What are the principles to guide the design of an IoT chatbot UX?

The first question one should ask themselves is "Why?". What is the chatbot for? What is it trying to achieve? What does the user expect to receive in response? The main task the chatbot is developed for is needed to be brought up in the initial user experience design. The design and the user interface must support the one task dedicated to the chatbot and it has to perform as smooth as possible. There are a lot of large enterprise-level organizations that have delivered various chatbot projects, but none of them have really succeeded in the way they would have desired. The problem is that the absolute reference is always a human being. The understanding and processing of human language is extremely difficult to overcome with artificial intelligence because the most natural thing of the human mind and behavior, is the human language. One could say that language is the factor that defines us as a species. Since our species is optimized in our own language, it is an extremely difficult task for an AI system to reach the same level. It is safe to state that if one assumes a bot will work just as well as a human being, they will most likely face a disappointment. However, that does not mean that the chatbot cannot be developed to function well in a strictly defined environment.

As mentioned earlier, Bieliauskas et al. (2017) have developed a Conversational User Interface, which is able to understand the user in common, natural language. They argue that the system should also be able to track the context of the conversation in order to lead the interaction in a semantic way. According to the research findings of this thesis, a semantic feature is not currently considered as a core component of UX design among Finnish developer organization. This may be due to the relative infancy of the technology. However, the findings indicate several similarities with the authors' arguments. In addition, as mentioned, Bieliauskas et al. (2017) define assistant systems as "software agents that are more general than a chatbot", which shares the same values with the research findings, emphasizing the role of directing the user to a suitable subsystem. Moreover, Kar et al. (2016) referred to Schermer (2007) and presented seven key characteristics of chatbots, quite similar to the seven components resulted from the research findings with a few exceptions. Next, a framework of chatbot UX components (Table 2) will be presented. The framework has been developed from the findings of the empirical study conducted with Finnish chatbot and IoT developers. The framework consists of seven UX components, which are explained in more detail in their own sections.

Components	Elements and examples
1. Dialogue and the type of language	Casual, normal-like, human-like
	Conversation leader
	Prompt delay feature
2. Proactivity and Efficiency	Questions or reminders by push notifications: Bot should remind and ask the user regularly about tasks that need to be executed.
	Frequency: Determining the frequency of notifications is important in order not to let the user experience it too overwhelming. The frequency of notifications has to be adapted to the user's preference.
	Efficiency: Quick functionalities. Even a second long delay can be a distraction.
3. Defined area of expertise	Closed and controlled environment: The user experience will more likely be positive and seem to the user that the bot performed exactly in the way it was supposed to.
	Informing the user the capabilities and limitations: Inform the user what sort of questions the chatbot is able to answer.
4. User intent refinement and End-user involvement	Refining the user intention through additional specifying questions
	End-user involvement: Involvement of the end-user in the early stages of user experience design
5. Visual look and feel	Personalization (e.g. user dashboard)
	Button shortcuts (e.g. menu, multiple-choice)
	Brand: Desired brand look and feel needs to transmit to the user as desired.

	Simplicity: The user interface must be understandable and self-evident in a way that the user is able to tell by a quick glimpse what they are able to do with the system. Non-technical persons must be able to use it.
	Visual effects: Notifying the user that the system is processing their request by presenting a moving icon
	Finished look and feel
6. Human service option and Culture	Opportunity to talk to a human: The user must at each point have the opportunity to talk to a human being. If the chatbot is not able to answer the user's question and human customer service is available, the user is immediately directed to the human customer service.
	Option to fill a contact form
	Cultural differences among users
7. Integration	Capability to integrate to various back-end systems.

Table 2: Chatbot UX framework

5.2.1 Dialogue and the type of language

The dialogue should be casual and provide the user an experience of a normal-like conversation. Developing a prompt delay feature into a chatbot is in some cases sensible. Technically, a chatbot system can provide the user an answer in milliseconds. However, one must take into account that for some user profiles it is not considered as natural behavior. If one wants to implement such a human-like feature into a chatbot, prompt delays could be built between questions and answers. In a way, to the user it seems like the chatbot is thinking and typing an answer. Some users like this, and some do not. It really depends on the user, which requires thorough pre-analysis of the user group. Some developers think it is too of a humane feature and they do not want to mislead the end-user.

The type of language the chatbot uses and how the chatbot conducts the conversation with a user, has an effect on what kind of feelings the user is left with after the interaction. It is quite obvious that the bot can never be able to know every solution to every problem. So how is it transmitted to the user that the chatbot is not able to solve their problem? If the chatbot simply states that "I do not have an answer to this. I do not understand.", the user may find the

chatbot unintelligent and useless. Thus, the chatbot must provide a wider answer followed up with next-step options to choose from.

5.2.2 Proactivity and Efficiency

The bot should be proactive. An interviewee stated that people in general think that a conversation with a bot is always initiated by the user. The conversation can just as well be started by the bot sending a push notification or a question to the user. In fact, the bot should remind and ask the user regularly about tasks that need to be executed. The frequency depends on the user's personal set up and must be modifiable. Determining the frequency of notifications, however, is important to take into notice in order not to let the user experience the notifications too overwhelming. The frequency of notifications has to be adapted to the user's preference.

If there are some things that do not need to be actively tracked but which may require some actions at some critical situation, the bot should automatically notify the user at those times. The user does not need to know about the actions until the situation reaches the stage of action needed. For example, if the user's lawn needs to be irrigated, the bot would notify the user and ask "The lawn is getting dry. Would you like it to be watered?" And, of course, if there are any active things what the user wants to know, the user should be able to inquire their current statuses. The user should be able to ask the inquiries in text format or the bot could automatically send them notifications at a specific time or location in order for the user to not be required to perform an action themselves.

In other words, the chatbot should have some level of automation. Automation means the system works autonomously. The Oxford English Dictionary Online (2018) defines automation as follows: "The action or process of introducing automatic equipment or devices into a manufacturing or other process or facility; (also) the fact of making something (as a system, device, etc.) automatic." In practice, the user would arrive at their cottage and it would already be heated to the desired temperature without the user needing to command the bot. Interviewees stated that this is what the user experience should be built on. Half of the interviewees brought up the requirement that the chatbot should work in a way where the user has certain personal logged activities in the system and those activities then execute the actions that need to take place at a certain time or place. The user would have a chatbot integrated in an application on a mobile device, which the user would use in order to let know the bot they are about to leave for their cottage, and the bot would perform the actions needed to be executed at the time when the user arrives at the cottage. Depending whether it is during summer or winter, for example. Interviewees found such a function to be a much more intuitive starting point for the user experience. In addition, two interviewees mentioned that the chatbot user experience development should move towards a user experience that is more similar to the way of interacting with a human being.

The system has to be capable of processing requests and functions fast enough so the user does not have to wait for the bot to send the requests to a central server which would take half a minute. For example, voice commands tend to have delays. Even a second long delay can be distracting to the user.

5.2.3 Defined area of expertise

The system environment must be as strictly defined as possible. Whenever a user is given the access to an open conversation there is a risk of the next functions of the process failing. Thus, if the chatbot operates in a closed and controlled environment, the user experience will more likely turn out to be positive, and it will more likely seem to the user that the bot performed exactly as it was supposed to. Therefore, it is important to inform the user about what sort of questions the chatbot is able to answer to. The area of activities the chatbot is set to handle, needs to be narrowed down and carefully defined. It is not preferable to attempt to develop a general "know-it-all" chatbot, but to develop a bot that is a specialist of its own defined area of expertise.

5.2.4 User intent refinement and End-user involvement

In order to develop a human-like, conversational chatbot environment, it is important for the end-user to be involved in the design. Since the development of a chatbot user experience culminates in the usage of the end-user, the end-user must not be ignored. The more the end-user is involved in the design, the less investment is needed in the future design. This can be compared to the term of technical debt that increases when the development team is attempting to carry out something too complex too fast, which most likely leads to a mess of an uncontrolled system that is difficult to maintain and inefficient to develop. Therefore, it is extremely important to include end-users as early as possible in the user experience design to minimize the post-expenses.

Also, user intent refinement increases the likeliness of a positive user experience. In case the user cannot find some information smoothly, the user could write to the chatbot, for example "What is the temperature at the cottage at the moment?" The bot could answer "Do you mean the indoor or outside temperature?". Refining the user intent should take place and an action related to it executed by the bot. In this way the bot guides the conversation and is able to provide more detailed information. The interaction between the user and the bot is therefore more conversational and human-like, which drives the implication of a low threshold chatbot usage.

5.2.5 Visual look and Personalization

Most of the interviewees mentioned personalization as one of the most important elements in the development of a chatbot user experience. The bot

should have a personalized dashboard that would provide quick button shortcuts so the user does not need to spell the required action to be executed but press a button that directs to the desired information. In fact, four out of six interviewees mentioned a clickable button as a good user experience element. The best solution considered among the interviewees were a menu or multiple-choice-answers to choose from. Providing clickable buttons is a relatively simple and useful feature to enhance user experience in chatbot environments, since the user is not required to use time in texting. This element should be in both desktop and mobile interfaces, but especially in mobile.

The visual aspect of the chatbot plays a key role in the user experience. If the chatbot outputs text only, the user experience will not be complete, since it will lack the graphical presentation in order to complement the answer. It is important to note that many bots require a visual answer added beside the text based answer in order to fully provide a solid answer that the user may find useful. Added URL links are not recommended, since users in general do not want to be diverted elsewhere from the current environment. These so called question-answer bots are starting to become relatively familiar to consumers, which eventually results in people expecting the bots being able to do so much more than just answering simple questions. It is important to specify what type of actions the chatbot is capable of performing. Thus, in a way, if a user asks a question, the bot should guide the user to the next level in the process or provide some action buttons for the user to click and proceed in the process. The mere text-based conversation does not seem be enough in today's chatbot conversations.

The chatbot user interface should be designed in a way that "non-technical" persons are able to use and modify its settings. The user interface must be understandable in a way that the user is able to know by a quick glimpse what they are able to do with the system. One should also avoid extensive user manuals. The functionalities and options need to be self-evident for the user. All in all, the user interface should have a finished look and feel.

5.2.6 Human service option and Culture

There has been one guiding factor in the development of chatbot user experience; the user must at all times have the opportunity to talk to a human being. Otherwise the process and user experience will most likely be defective. If the chatbot is not able to answer the user's question and a personnel from human customer service is available, the user should be immediately directed to the human customer service. For a company utilizing a chatbot, it means the traditional customer service being able to focus on more complicated issues and less on frequently asked repetitive questions.

There are some practical challenges, such as user frustration towards the chatbot. The frustration often results in user calling customer service, which may be is expensive for the service provider. The roles of different user profiles in developing user experience is also an immense challenge. The challenge lies

in the differences between user profiles and user experiences. If the user experiences the situation too demanding and the user prefers not to contact the service provider through another channel, they may switch to a competitor's services.

A good user experience occurs when the chatbot is capable of offering a contact form as an addition, for example, if the chatbot is not able to answer the question itself. The user can at least assume that they will be contacted later by a human service agent. In addition, the company benefits from the situation by gaining a possible business prospect. The bot asking the user a question is quite comparable to a traditional online fill-in form in which a user enters their contact information. By providing the user a form it is possible to make a direct assumption what the user is filling in, or in this context what the user's intent is.

The cultural differences among users is crucial to take into account. Especially when considering the Finnish consumer habits and culture in general. It needs to be clear for the developer organization for what type of user profiles the system is developed. For example, Finnish people tend to keep to themselves and may not be as extroverts as other nationalities. Moreover, currently the artificial intelligence development and related technology regarding the Finnish culture and Finnish language are in their infancy. This makes the development challenging but also rewarding.

5.2.7 Integration

The core idea of a chatbot acting as a master portal for managing several IoT devices loses its meaning if the chatbot system is not integrable. When it comes to user experience, the developer's goal is not to interfere with the integrations when the portal system is in use, but to let the user manage and install the integrations by themselves. This means that the user can integrate new IoT devices into the chatbot portal without any external help. Therefore, the system must be integrable and ready for future external systems.

6 DISCUSSION

Based on the literature review and the empirical research of this thesis, I argue that combining the fact of an increase in IoT devices in consumer markets with the need of a simplified way for a user to manage multiple IoT devices, chatbot technology is a key tool for providing an approachable environment to the need. Nevertheless, there still are challenges in designing and developing a unified channel, since the setup is still in its early stages. There is a definite need for further research on a unifying channel that can be used to manage multiple IoT devices by using natural language. Especially empirical research done with developers and end-users is crucial for the creation of design principles for this context. The research results may be used for further development of chatbots in an IoT environment and possibly in other applicable areas, such as ecommerce.

6.1 Implications to research

The reason why many chatbots often even exist is that web applications, or in this case mobile applications, are easily transformed by the developers into really complex environments for the user to operate. When there are a lot of functionalities and information integrated into the system, it is likely that the system becomes challenging for the user to find the right place to execute a needed action, or to collect all the desired information in one place.

This study aimed to find the key elements of guiding the user experience design for an IoT chatbot by creating a framework for future development. Hassenzahl et al. (2006) argue that the evolution of UX is driven by three factors: commercial vendors, designers, and scientific community. According to the research findings, what is relatively surprising, all but one of the interviewed chatbot technology organizations have no in-house user experience support for the design, nor do they focus on the user experience design at all. Thus, one of

three UX evolution drivers (Hassenzahl et al., 2006) is currently lacking in most of the developer organizations.

As mentioned earlier, Hassenzahl et al. (2006) divide user experience into three affecting top-level perspectives: (1) *Beyond the Instrumental*, (2) *Emotion and Affect*, and (3) *The Experiential* perspective. Based on the empirical research of this study, similar elements were recognized among the interviewees' answers. Hedonic, aesthetic and pragmatic values were relatively predictable elements mentioned by the interviewees. As an extension to the perspectives by Hassenzahl et al. (2006), based on the findings, I argue an addition of a humane factor in this context is appropriate. The option of being able to interact with a human being must be present to the user at all times.

6.2 Implications to practice

The aim of this research was to create a framework of guiding the UX design of an IoT chatbot that would in the future help the developer organizations in focusing their design and development on the most essential UX components. The created framework consists of seven components, or guidelines, four of which were emphasized the most in the research interviews: *Defined area of expertise, Visual look and feel, Dialogue and the type of language,* and *Human service option.*

In designing user experience for a chatbot, the first guideline is to define the area of expertise of the chatbot. The chatbot specifying in one area of service is significantly more practical than attempting to develop a know-it-all system. Furthermore, it is extremely important to notify the user as clear as possible what area of questions the chatbot is capable of answering. This way any risks of user disappointments or frustrations can be minimized.

The second important guideline is the visual look and feel of the chatbot. The hedonic values play a major role in user experience in general. A chatbot environment is no exception. To support the initial idea of providing the users of IoT devices an easy solution to control their devices through one chatbot portal, the easiness must not end there. The user must be able to experience that the chatbot environment is simple to use, understandable, and has an overall finished look and feel. The aim is to provide a system that the user enjoys using and that it simplifies their daily life.

Thirdly, a chatbot can decrease manual labor from human service agents, but it can also cause serious damage to the public image of the service provider if the language the chatbot uses is in any way inappropriate or misleading. It is crucial to take into account how the chatbot interacts with the user, and especially how it should not. That said, the proper use of language can also be a major benefit in guiding the conversation between the bot and the user. According to the research findings, it is advisable to minimize the user let the chatbot take full charge of leading the conversation. In that way the

conversation will more likely result in securing the brand image and providing the user their desired service.

The fourth guideline, human service option, aims to minimize the users' frustration, provide an optional way of interacting, and make the process more straightforward. The user should have the option of talking to a human being at all stages of the conversation with a chatbot. The purpose of a chatbot is not to fully replace humans but to act as a contribution to the service that always provides an easy exit to a more traditional way of interaction.

6.3 Challenges

One of the biggest problems or threats in risk management is uncontrolled answers from autonomous chatbots. Thus, structural approaches often tend to raise a lot of support from developers, because in structural solutions the developers are able know in advance what kind of responses the chatbot will offer to the user. Structural approaches can also be implemented when the solution exploits natural language processing technology, but dynamic artificial intelligence technology is considered in the corporation world with a caution due to the risk of the chatbot learning improper things. This has been one of the major drivers in the development of chatbot technology. A chatbot is like an infant that needs time and care in order to learn proper things correctly. In a way, the education should take place under controlled conditions and not controlled by the Internet.

Two of the interviewees mentioned a challenge of how to instruct the user in using the system. One organization solved it by creating video lessons. One must take into notice that the system becomes difficult to use surprisingly fast as more functions are added. Another challenge that has emerged in the development is how to edit answers easily in a mobile application. It is important that the bot is leading, helping, and advising at first, but later on it is vital to provide the option to the user to have access to the content directly.

7 CONCLUSION

The aim of this thesis was to study how to guide the design of an UX for a chatbot that can be used to control several personal IoT devices. As mentioned above, personal IoT devices, such as smart home devices, are rapidly increasing among consumers. Controlling multiple devices through multiple different applications can be an alienating factor for a common consumer, even if it made the user's everyday life easier. The consumer wants to make his or her life easier, but without the need of obtaining a high technological knowledge and skills. However, our society is at the point where most of today's consumers are familiar with conversational texting environments, such as sending text messages or instant online messages to other people. Kar et al. (2016) argue that a unifying user interface with a chat environment for managing multiple IoT devices could act as a low threshold for the common user to adopt new technology. In addition, Bieliauskas et al. (2017) state that a conversational user interface, such as a chatbot, would be a suitable solution for a human to interact with a computer system, rather than an assistant system that can only execute simple tasks. I argue that providing the users a familiar entry to the world of IoT devices will significantly increase the sales of IoT devices and the usage in the consumer markets.

As technology evolves, not only is the amount of technology-aware consumers increasing, but so are the demands of technology usability levels from the consumers as well. The consumers demand more with less effort, and this can also be applied to IoT device management. This thesis has reviewed previous literature in order to define the key concepts related to the subject, looked at the literature of chatbot implementations and design in general, and investigated how to guide the UX design of an IoT chatbot. The thesis proposed that a unifying IoT chatbot controlling multiple devices in natural language could make managing IoT devices more convenient and user-friendly to the user. In addition, a more familiar way of interacting with computers could attract a larger crowd to use new technology. Although little research has been made on declaring the design principles of an IoT chatbot, the need of such system has been disclosed and the fundamentals of chatbot agent characteristics

have been clearly noted. I argue that there is a need to combine these fields of technologies and conduct an empirical study in order to develop the suitable design principles.

7.1 Limitations of the study

There are noticeable limitations in the research. First, this study was a qualitative research of only Finnish developer organizations and therefore the sampling was relatively limited. In addition, since it appeared challenging to gather more than six Finnish developer organizations to participate in the research, some variations in the results could have occurred with a larger crowd. However, it seemed that the interviewed Finnish developers mainly shared the same vision of current and future development. Second, the research solely focused on the developers and did not take into account the opinions of the end-users, which form one of the key factors in developing successful user experience. Third, since there were no practical demonstrations or existing benchmarks to evaluate the validity and reliability of the study, an external evaluator - in this case the Master's thesis supervisor - reviewed the solution.

7.2 Recommendations for further research

The research results of this thesis may be used for further development of chatbots in an IoT environment and conceivably in other applicable areas, such as e-commerce, education, and customer service in general. This thesis reviewed the opinions and future estimates of Finnish developer organizations in guiding the design of user experience for chatbots. Since the study did not include any end-users in the empirical research, I believe it would be essential to extent the research on the view of the end-users, especially in the Nordic countries. According to the reviewed literature and the empirical research of this study, currently there is not an entirely clear academical nor professional consensus of how the interaction of people with a human being differs from the interaction with a chatbot system. Further research ought to be done with a wider spectrum of how a human being behaves with a chatbot that contains artificial intelligence. In addition, actions triggered by a location or specific time considering the user experience in IoT chatbot environments is an area of which the interviewed organizations had no or little experience of. Nor to my knowledge are there many academic studies conducted for the subject.

BIBLIOGRAPHY

References

Banerjee, I., Nguyen, B., Garousi, V., & Memon, A. (2013). Graphical user interface (GUI) testing: Systematic mapping and repository. *Information and Software Technology, 55*(10), 1679-1694.

Baral, C., & Gelfond, M. (2000). Reasoning agents in dynamic domains. *Logic-Based Artificial Intelligence, 597*, 257-279.

Bergman, J., Olsson, T., Johansson, I., & Rassmus-Gröhn, K. (2018, March). An exploratory study on how Internet of Things developing companies handle User Experience Requirements. In *International Working Conference on Requirements Engineering: Foundation for Software Quality* (pp. 20-36). Springer, Cham

Bieliauskas, S., & Schreiber, A. (2017, September). A Conversational User Interface for Software Visualization. In *Software Visualization (VISSOFT), 2017 IEEE Working Conference on* (pp. 139-143). IEEE.

Chaturvedi, A. R., Dolk, D. R., & Drnevich, P. L. (2011). Design principles for virtual worlds. *Mis Quarterly,* 673-684.

FDIS, I. (2009). 9241-210: 2009. Ergonomics of human system interaction-Part 210: Human-centered design for interactive systems (formerly known as 13407). International Organization for Standardization (ISO). Switzerland.

Everett, S. P., Byrne, M. D., & Greene, K. K. (2006, October). Measuring the usability of paper ballots: Efficiency, effectiveness, and satisfaction. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 50, No. 24, pp. 2547-2551). Sage CA: Los Angeles, CA: SAGE Publications.

Ferber, J. (1999). Multi-agent systems: an introduction to distributed artificial intelligence (Vol. 1). Reading: Addison-Wesley.

Goertzel, B. (2010, June). Toward a formal characterization of real-world general intelligence. In *Proceedings of the 3rd Conference on Artificial General Intelligence, AGI* (pp. 19-24).

Gottfredson, L. S. (1997). Mainstream science on intelligence: An editorial with 52 signatories, history, and bibliography.

Haavisto, E. (2015). Chatbot-teknologia : sähköinen kaupankäynti ja asiakaspalvelu. *JYX, jyx.jyu.fi*.

Hassenzahl, M., Tractinsky, N., 2006. User experience – a research agenda. Behaviour & Information Technology 25 (2), 91–97.

Hassenzahl, M. (2008, September). User experience (UX): towards an experiential perspective on product quality. In *Proceedings of the 20th Conference on l'Interaction Homme-Machine* (pp. 11-15). ACM.

Hovy, E., Navigli, R., & Ponzetto, S. P. (2013). Collaboratively built semi-structured content and Artificial Intelligence: The story so far. *Artificial Intelligence*, *194*, 2-27.

Huang, J., Zhou, M., & Yang, D. (2007, January). Extracting Chatbot Knowledge from Online Discussion Forums. In *IJCAI* (Vol. 7, pp. 423-428).

Kar, R., & Haldar, R. (2016). Applying chatbots to the internet of things: Opportunities and architectural elements. *Ar Xiv Preprint arXiv:1611.03799,*

Khanna, A., Das, B., Pandey, B., Hussain, D. M. A., & Jain, V. (2016). A Discussion about Upgrading the Quick Script Platform to Create Natural Language based IoT Systems. *Indian Journal of Science and Technology*, *9*(46).

Khokhar, S., Zin, A. A. B. M., Mokhtar, A. S. B., & Pesaran, M. (2015). A comprehensive overview on signal processing and artificial intelligence techniques applications in classification of power quality disturbances. *Renewable and Sustainable Energy Reviews*, *51*, 1650-1663.

Kujala, S., Roto, V., Väänänen-Vainio-Mattila, K., Karapanos, E., & Sinnelä, A. (2011). UX Curve: A method for evaluating long-term user experience. Interacting with Computers, 23(5), 473-483.

Kummerfeld, B., & Kay, J. (2017). User modeling for the internet of things. *Proceedings of the 25th Conference on User Modeling, Adaptation and Personalization,* 367-368.

Law, E. L. C., & Van Schaik, P. (2010). Modelling user experience–An agenda for research and practice. Interacting with computers, 22(5), 313-322.

Law, E. L. C., Van Schaik, P., & Roto, V. (2014). Attitudes towards user experience (UX) measurement. *International Journal of Human-Computer Studies*, *72*(6), 526-541.

Lee, I., & Lee, K. (2015). The internet of things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons, 58*(4), 431-440.

Mori, M. (1970). The uncanny valley. *Energy, 7*(4), 33-35.

Murphy, K. (1991). *Machine Learning: A Probabilistic Perspective*. The MIT Press.

Nielsen, J. (1996). Usability metrics: Tracking interface improvements. *IEEE Software*, *13*(6), 12.

Parasuraman, R., Sheridan, T. B., & Wickens, C. D. (2000). A model for types and levels of human interaction with automation. *IEEE Transactions on systems, man, and cybernetics-Part A: Systems and Humans*, *30*(3), 286-297.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems, 24*(3), 45-77.

Schermer, B. W. (2007). *Software agents, surveillance, and the right to privacy: A legislative framework for agent-enabled surveillance* Leiden University Press.

Seffah, A., Donyaee, M., Kline, R. B., & Padda, H. K. (2006). Usability measurement and metrics: A consolidated model. *Software Quality Journal*, *14*(2), 159-178.

Siau, K., & Yang, Y. (2017, May). Impact of Artificial Intelligence, Robotics, and Machine Learning on Sales and Marketing. In *Twelve Annual Midwest Association for Information Systems Conference (MWAIS 2017)* (pp. 18-19).

Smith, S. L., & Mosier, J. N. (1986). *Guidelines for designing user interface software* Mitre Corporation Bedford, MA.

Tullis, T., Albert, W., Dumas, J. S., & Loring, B. A. (2008). Measuring the User Experience: Collecting Analyzing, and Presenting Usability.

Turing, A. M. (1950). Computing machinery and intelligence. *Mind,* 59(236), 433-460.

Commercial references

"automation, n." *OED Online*, Oxford University Press, December 2018, www.oed.com/view/Entry/13468. Accessed December 4th, 2018.

Chalfen, M., (2015) https://techcrunch.com/2015/10/15/machine-learning-its the-hard-problems-that-are-valuable/ (Retrieved 18th of January 2018)

"Gartner Says 6.4 Billion Connected 'Things' Will Be in Use in 2016, Up 30 Percent From 2015," Gartner Press Release, November 10th, 2015; accessed atwww.gartner.com/newsroom/id/3165317.

LeBlanc, M., (@martinleblanc), May 14th 2014. "A user interface is like a joke. If you have to explain it, it's not that good." [Twitter Post], Retrieved December 23rd 2018 from https://twitter.com/martinleblanc/status/466638260195041280

Nielsen, J., 2008. Usability ROI Declining, but Still Strong. Column Posted on the WWW 22/1/2008. <http://www.useit.com/alertbox/roi.html>

Sharma, G., (2016) https://chatbotsmagazine.com/artificial-intelligence-ai-and-fintech-part-1-7cae1e67dc13 (Retrieved 18th of January 2018)

Van Lun, E. *Chatbot - artificial person with interactive textual conversation skills.* Retrieved 29.09.2017 from https://www.chatbots.org/chatbot/

APPENDIX 1: Interview sheet – questionnaire guide

Haastateltavien profiilit: ohjelmistokehittäjä, liiketoimintakehittäjä, teknologiajohtaja

1. Alustus [5 min]

- Esittele itsesi
- Kerro tutkimuksen taustasta
- Mihin haastattelun tuloksia käytetään
- Luottamuksellinen haastattelu
    - Ei keskustella sellaisista asioista, jotka koskevat liikesalaisuuksia
- Kysy lupa haastattelun äänitykseen
- Kysy haastateltavan työnimike, työtehtävät, kuinka kauan ollut töissä ko. firmassa

2. "Kuvittele" [5 min]

- **Mitä ajatuksia tämä herättää?**
- Miten botti voisi auttaa?
- Miten haluaisit käyttää bottia tähän tehtävään?
- Muita huomioita?

3. Kysymykset

3.1 IoT ja chatbot [5-10 min]

- **Miten teidän yrityksen kehittämää bottia voisi käyttää tähän?**
    - Entä millaisia kokemuksia sinulla on chatboteista tähän mennessä?
- Millaisia ominaisuuksia arvostat chatboteissa?

- Mitä chat-ympäristöjä olet käyttänyt (esim. Slack, Skype, Whatsapp)?
    - Mitä chat-ympäristöä käytät eniten?
    - Kuinka paljon aikaa arviolta vietät aikaa chat-ympäristöissä vuorokaudessa?
- **Miten olette yrityksessänne lähteneet kehittämään käyttäjäkokemusta chatbotille?**
    - Mistä olette aloittaneet?
    - Ketä kehityksessä on ollut mukana?
    - Miten loppukäyttäjän näkökulma on otettu huomioon?
    - Kuvaile tyypillistä kehitysrunkoa ja mihin se perustuu.
- Miten kuvittelet käyttäväsi erilaisia IoT-laitteitasi tulevaisuudessa?
    - Jos saisit valita, mikä olisi ihanteellisin tapa? Miten? Missä? Milloin?

3.2 Käyttäjäkokemus (UX) [10 min]

- **Miten kuvailisit käsitettä käyttäjäkokemus?**
- **Mitä käyttäjäkokemus merkitsee sinulle?**
- **Miten kuvailisit hyvää käyttäjäkokemusta?**
    - Mistä elementeistä se mielestäsi koostuu?
- **Mitä asiakkaanne sinun mielestäsi arvostavat käyttäjäkokemuksessa?**
- Miten päätökset käyttäjäkokemuksen toteutuksesta syntyvät yrityksessänne? (Bergman et al., 2018)
    - Keskittyykö kehitys käyttäjän tarpeisiin, käyttäjän osallistuttamiseen suunnittelussa, ainoastaan itse tuotteeseen, tms.?
    - Jos käyttäjä osallistutetaan suunnitteluun, miten se on toteutettu ja missä vaiheessa?
- **Havaintoja onnistuneista käyttäjäkokemuksista liiketoiminnassanne tai yleisesti?**
- **Osaatko mainita joitakin tekniikoita, joihin teidän käyttäjäkokemuksen kehitys ja/tai suunnittelu perustuu? (**Bergman et al., 2018)
- Mitkä ovat mielestäsi tällä hetkellä käyttäjäkokemuksen puutteet mobiiliapplikaatioissa?

- Entä etenkin chat-ympäristöissä?

- **Mihin käyttäjäkokemuksen kehitys on sinun mielestäsi suuntautumassa?**

3.3 Tarkentavia kysymyksiä haastattelijalle

- Mitä tarkoitit vastauksellasi…
- Voitko antaa esimerkin…
- Voisitko kertoa lisää…
- Miksi koet asian juuri noin?
- Sanoit että x oli onnistunut… Mitä tarkoitit onnistumisella?
- Onko jotain muuta mitä haluaisit sanoa tai kysyä?
- Voisitko kuvailla...
- Mitä positiivisia / negatiivisia puolia on…

KUVITTELE [1 / 2]

Istut luentosalissa kuuntelemassa kiinnostavaa seminaaria, josta et voi poistua.

Olet lähdössä seminaarin jälkeen viikonlopuksi mökille upouudella Teslallasi.

Mieleesi herää reissuun liittyviä kysymyksiä, jotka olisi selvitettävä pikaisesti, jotta pystyt varautumaan tarvittaviin toimenpiteisiin mahdollisimman ajoissa ja tehokkaasti.

KUVITTELE [2 / 2]

Sinulla on näiden tarpeiden ja laitteiden käyttöön puhelimessasi omat sovellukset jokaiselle erikseen. Kaikki siis pitäisi käydä yksitellen läpi ja kaikilla sovelluksilla on omat käyttöliittymänsä, jotka todennäköisesti eivät jaa samaa käyttäjäkokemusta keskenään, eivätkä siten toimi loogisesti yhteen.

Entä jos voisit hetkessä kysyä kaikki nämä asiat ja tehdä tarvittavat toimenpiteet mobiililaitteellasi käyttäen yhtä chat-portaalia luonnollisella kielellä? Et häiritsisi muita, eikä sinun tarvitsisi poistua paikalta. Tarvittavat asiat on selvitetty ja hallinnoitu hetkessä, ja olet valmis viikonloppua varten.